REMARKS

A. The Oath/Declaration Issue

Paragraph 6 of the Office Action of October 5, 2009 objected to the Declaration in this application on the ground that the last digit (after the decimal point) of one of the two foreign priority applications listed in the Declaration did not agree with the corresponding digit of this priority application as listed in the priority document from the International Bureau.

Following telephone conferences by Applicants' attorney with individuals at the USPTO/PCT Help Desk and thereafter with Examiner Yamnitzky, it was determined that this minor inconsistency could be corrected by the filing of an Application Data Sheet in accordance with 37 C.F.R. §1.76. Such an Application Data Sheet was then filed with the USPTO on November 12, 2009. Accordingly, it is respectfully submitted that this matter has now been fully addressed.

B. Amendments to the Specification

Applicants have herein submitted amendments to the Specification in an effort to address the issues raised in paragraphs 5 and 7 of the Office Action, and to support the corresponding claim amendments. First, as requested by the Examiner, the proposed change in the last Amendment and Response from "second" to "first" in the paragraph bridging pages 2 and 3 of the Specification has been canceled and the language of the original has been restored. Second, the following new revisions to the subject paragraph are proposed:

Page 2, line 30 – "second" is changed to - - first - - .

Page 3, line 1 – "LOMO" is changed to - - LUMO - - .

Page 3, line 1 – “”occupied” is changed to - - unoccupied - - .

These corrections in the subject paragraph would make this paragraph consistent with the way the Examiner seems to be interpreting this description in paragraph 7 of the Office Action, consistent with generally recognized convention in this field, and also consistent with the inventors' intent, despite the unintentional errors in the original Specification. The undersigned attorney apologizes for any confusion on the part of the Examiner that might have been caused by the last Amendment and Response in this regard.

This situation was occasioned by the inability of the undersigned attorney to obtain clarification about the ambiguities in the subject application paragraph from foreign counsel (now deceased) who drafted the original application, or from the inventors (who were then not accessible) prior to the Response deadline. The undersigned attorney submitted the last Amendment and Response in the good-faith, though mistaken, belief that he was correctly interpreting the subject paragraph in accordance with the rest of the disclosure.

The corrective amendments to the Specification submitted herewith have been confirmed by the inventors as representing their original intention, and a Rule 132 Declaration can be submitted if requested by the Examiner to support these amendments. It is also respectfully submitted that those of ordinary skill in this art would have immediately recognized the terminology errors in the original Specification paragraph and would have correctly interpreted this disclosure consistent with the proposed corrective amendments.

Accordingly, Applicants respectfully request that the proposed amendments to the Specification be approved and entered.

C. **Paragraphs 8 and 10 of the Office Action**

Applicants respectfully request that the Sec. 112, first and second paragraphs, claim rejections of paragraphs 8 and 10 of the Office Action be reconsidered and withdrawn in view of the claim amendments made herein and the following Remarks.

Independent Claims 74, 88 and 91 now recite "wherein the highest occupied molecular orbital (HOMO) of the first complex is higher, and the lowest unoccupied molecular orbital (LUMO) of the first complex is lower, than those of the second complex…." This claim recitation is consistent with the paragraph bridging pages 2 and 3 of the Specification as herein amended.

Thus, the claims have been amended in response to the Examiner's observation in paragraph 4 of the Office Action that the expression "LOMO" should read "LUMO". It is respectfully submitted that it would have been clear to a skilled reader from the Specification, when read as a whole, that the recitation of "lowest occupied molecular orbital (LOMO)" was in error and that what was meant here was "lowest unoccupied molecular orbital (LUMO)." The subject paragraph explains how light is emitted by electronic transitions in a molecule. As is well recognized in this art, the lowest occupied molecular orbital is never involved in such transitions. This is because the lowest occupied MO is fully occupied with electrons and therefore is electronically shielded and substantially inert. Light emission is caused by electronic transitions from excited states to orbitals which are not already fully occupied with electrons.

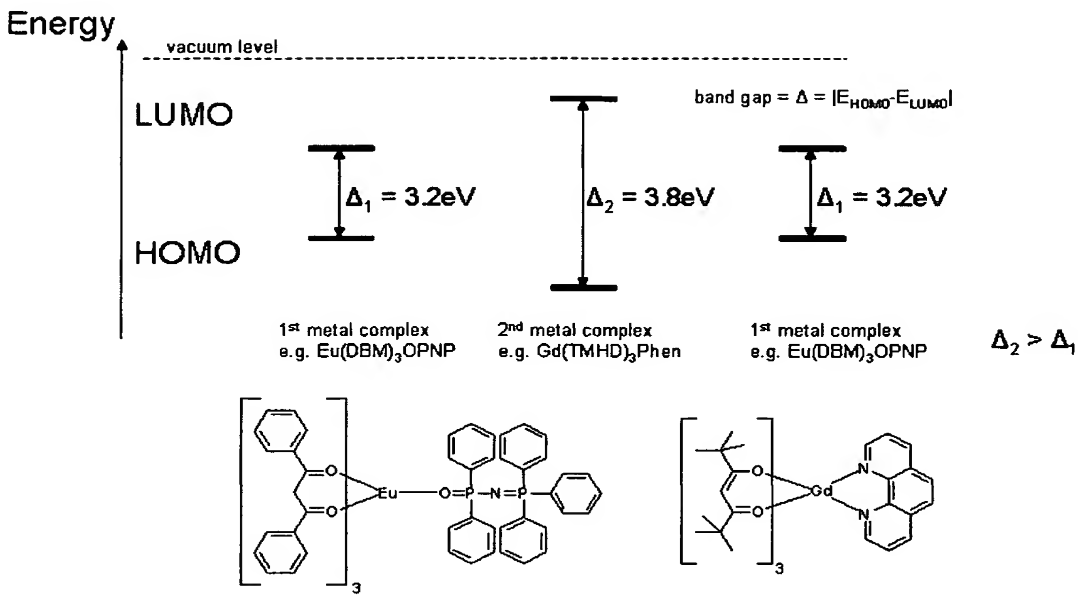
Typically light emission is caused by transitions from excited electrons populating the LUMO, which drop back to the HOMO. Furthermore, organic semiconductors as described in the present application are characterized as employing the frontier orbitals

(HOMO/LUMO). One skilled in the art would always know that "LUMO" was meant, rather than "LOMO," in such discussions. From the context of the subject paragraph of the Specification and the terminology generally used in this field, both the existence of the error and the appropriate and necessary correction would have been obvious to a skilled reader of the Specification at the time of the application.

Similarly, it would have been unambiguously clear to a skilled person that writing "second" instead of "first" in the subject paragraph of the Specification was an obvious clerical error. Such clerical error would have been unambiguously apparent to a skilled person because the contrary meaning contradicts repeated statements throughout the application that it is the second layer that has the wider band gap.

The Examiner has invited the Applicants to indicate the HOMO and LUMO levels of the materials in the working examples of this application to provide additional clarity, and Applicants have done so below. Upon the Examiner's request, this information can be more formally submitted in a Rule 132 Declaration.

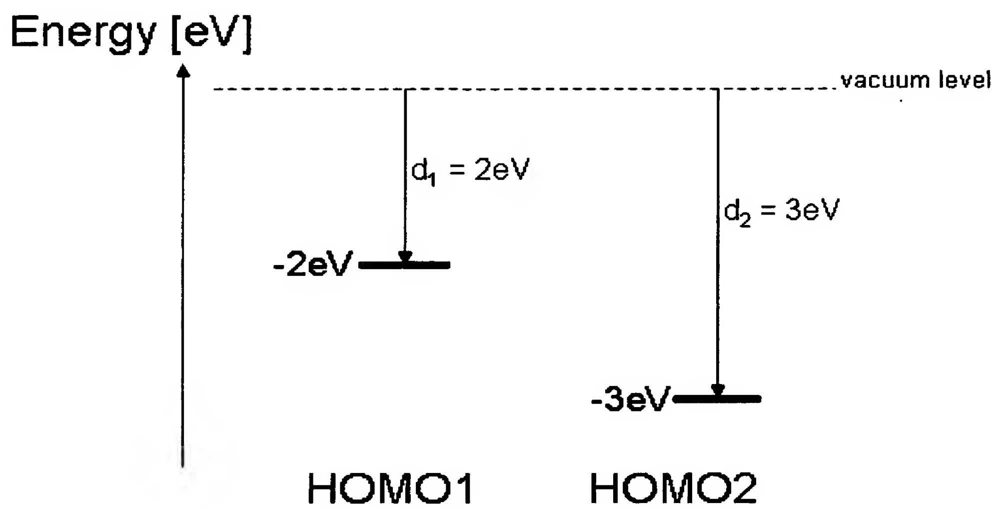
In Example 1 the relevant materials are $Eu(dbm)_3OPNP$ and $Gd(tmmd)_3phen$, and the energy levels are as set out below. The species and the HOMO and LUMO levels of the materials exemplified are also as set out below:



The Examiner also raised a question concerning a metal having a molecular orbital. However, from both the literal sense and the context of the paragraph of the Specification, it is clear that the metal is part of a complex ("... the metal in the second electroluminescent metal complex ..."). The skilled person in this art understands that if a metal or another atomic or molecular entity is part of a molecule, the orbitals are distributed over the entire molecule. In the present case, this means that the molecular orbital is distributed over the metal and the ligands. From the fact that molecular orbitals, rather than atomic orbitals, are discussed, a skilled person would never have any questions about the meaning of this part of the sentence. In the field of organic semiconductors, the HOMOs and LUMOs of the entire molecule are relevant rather than those of fragments or atoms which are only parts of the whole molecule.

As regards the meaning of "higher" and "lower" in the present application and context, there is a recognized ambiguity in this art as between reference to levels and

energies. At least two different approaches exist in order to characterize the position of the frontier orbitals. For this purpose one can use absolute energies of the frontier orbitals or their relative distances from the vacuum level. Consider, for instance, the two following HOMOs:



According to the first approach (absolute energies), HOMO1 (-2 eV) is "higher" as compared to HOMO2 (-3 eV). The situation reverses, however, if the relative approach is applied. In that case, the HOMO2 (d2 = 3 eV) is "higher" compared to HOMO1 (d1 = 2 eV). However, with regard to the claims of this application, it does not matter which way "up" on the energy diagram is viewed: the relationship between the orbitals and the band gaps in the first and second complexes remains precisely the same regardless of which orientation is used.

D. Paragraph 9 of the Office Action

Applicants respectfully request that the Sec. 112, first paragraph claim rejection of paragraph 9 of the Office Action be reconsidered and withdrawn in view of the claim amendments made herein and the following Remarks.

Claims 83 and 99 have been amended herein to make it clear that "Phen" in the recited compound Gd(DBM)$_3$Phen refers to phenanthroline, a neutral ligand, not to phenanthrene. As noted by the Examiner, phenanthrene is not within the scope of any of the formulae set forth in the Specification as examples of Lα or Lp, and phenanthrene is not a neutral ligand. There is no disclosure or suggestion anywhere in the Specification to use phenanthrene as a ligand. By contrast, phenanthroline clearly comes within Formula XVIV of the Specification, it is a neutral ligand, and it does not give rise to the oxidation state problems identified by the Examiner. As shown by the attached Wikipedia entry, phenanthroline is a bidentate ligand in coordination chemistry, is commonly abbreviated "phen," and is known for forming strong complexes with most metal ions. It is respectfully submitted that this explanation obviates the Examiner's objection on this issue.

E. Paragraph 11 of the Office Action

In response to paragraph 11 of the Office Action, Applicants have herein canceled Claim 103 without prejudice solely to avoid the duplicate claim objection of this paragraph.

SUMMARY AND CONCLUSIONS

For all of the foregoing reasons, Claims 74, 76-83, and 85-102 are believed to be in condition for allowance and an early notice thereof is earnestly requested.

Respectfully submitted,

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Phenanthroline

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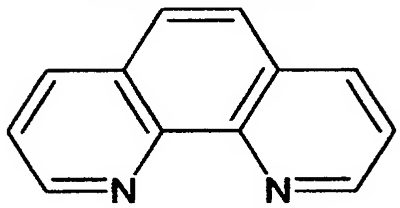
Phenanthroline



IUPAC name	[show]
Identifiers	
CAS number	66-71-7 ✓
RTECS number	SF8300000
SMILES	[show]
Properties	
Molecular formula	$C_{12}H_8N_2$
Molar mass	180.21 g/mol
Appearance	colourless crystals
Density	1.31 g/cm^3
Melting point	117 °C
Solubility in water	moderate
Solubility in other solvents	acetone
Hazards	
R-phrases	R25, R50/53
S-phrases	S45,S60,S61
Related compounds	
Related compounds	2,2'-bipyridine ferroin phenanthrene

✓ (what is this?) (verify)

Except where noted otherwise, data are given for materials in their standard state (at 25 °C, 100 kPa)

Infobox references

Phenanthroline is a heterocyclic organic compound. As a bidentate ligand in coordination chemistry, commonly abbreviated "phen," it forms strong complexes with most metal ions. In terms of its coordination properties, phen is similar to 2,2'-bipyridine (bipy).

Contents

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[edit] Synthesis

Phenanthroline may be obtained by refluxing *o*-phenylenediamine, sulfuric acid, glycerol, a solution of arsenic acid, and water.[1]

[edit] Ferroin and analogues

The complex $[Fe(phen)_3]^{2+}$, called "ferroin," is used for the photometric determination of Fe(II).[2] It is used as a redox indicator with standard potential +1.06 V. The reduced ferrous form has a deep red colour and the oxidised form is light-blue. Ferroin is used as a cell permeable inhibitor for metalloproteases in cell biology.

The pink complex $[Ni(phen)_3]^{2+}$ has been resolved into its Δ and Λ isomers.[3] The analogous $[Ru(phen)_3]^{2+}$ has long been known to be bioactive.[4]

[edit] Related ligands

In the related compound "bathophenanthroline," the 4 and 7 positions are substituted by phenyl groups.

[edit] As an indicator for alkyl lithium reagents

Alkyl lithium reagents form deeply colored derivatives with phen. The alkyl lithium content of solutions can be determined by treatment of such reagents with small amounts of phen (ca. 1 mg) followed by titration with alcohols to a colourless endpoint.[5]

[edit] References

1. ^ B. E. Halcrow, W. O. Kermack (1946). "43. Attempts to find new antimalarials. Part XXIV. Derivatives of o-phenanthroline (7 : 8 : 3′ : 2′-pyridoquinoline)". *J. Chem. Soc.*: 155–157. doi:10.1039/jr9460000155.
2. ^ Belcher, R. "Application of chelate Compounds in Analytical Chemistry" Pure and Applied Chemistry, 1973, volume 34, pages 13-27.
3. ^ George B. Kauffman, Lloyd T. Takahashi (1966). "Resolution of the tris-(1,10-Phenanthroline)Nickel(II) Ion". *Inorg. Synth.* **5**: 227–232.
4. ^ F. P. Dwyer, E. C. Gyarfas, W. P. Rogers, J. H. Koch (1952). "Biological Activity of Complex Ions". *Nature* **170**: 190–191. doi:10.1038/170190a0.
5. ^ Paul J. Fagan and William A. Nugent (1998), "1-Phenyl-2,3,4,5-Tetramethylphosphole", *Org. Synth.*,

http://www.orgsyn.org/orgsyn/orgsyn/prepContent.asp?prep=CV9P0653; *Coll. Vol.* **9**: 653